Plate III., as it seemed worth while drawing fresh attention to this very remarkable bird.

I have visited Rennell twice and Bellona once since the visit above described, in the British Solomon Islands Protectorate Government steamer, but on neither occasion was I able to land.

V.—*Studies on the Charadriiformes**.—III. *Notes in Relation to the Systematic Position of the Sheath-bills* (Chionididæ). By Percy R. Lowe, M.B., M.B.O.U.

(Text-figures 1–4.)

That the true affinities of this extremely interesting group of birds have been a source of perplexity to ornithologists is sufficiently obvious from the literature on the subject, and from the long array of naturalists who have in turn attempted to solve this problem since the time when Forster, the companion of Cook on his second voyage (1772–73), first discovered the Sheath-bill.

Thus De Blainville (Ann. Sci. Nat. vi. 1836, p. 97) says : "After Forster, a great number of naturalists, among whom were Pennant, Latham, Gmelin, Bonnaterre, Illiger, Vieillot, Oken, Temminck, Goldfuss, the Abbé Ranzani, Quoy & Gaimard, Lesson, Wagler, Cuvier, and Isidore Geoffroy St. Hilaire, successively occupied themselves with *Chionis*, and nearly all assigned it to a different position" (Transl.). He then proceeds to state his reasons for considering that the genus in question (the only one then recognised) is most nearly allied to the Oyster-catchers (*Hæmatopus*).

From this point, R. W. Shufeldt, in a review of the opinions on the systematic position of the Chionididæ

* In describing the palatal region of the Jack-Snipe in my paper on the Chatham Island Snipe ('Ibis,' October 1915, p. 711), I remarked :— "So far as I am aware, this region in the Jack-Snipe has never been previously described." I regret to say that this was an error, for Mr. F. E. Beddard, F.R.S., had, unbeknown to me, previously called attention to its aberrant nature (*cf.* P. Z. S. 1901, p. 599).

('Auk,' vol. x. No. 2, April 1893), cites a number of authors* who have taken up the story. Among these may be mentioned Eyton, Cunningham, Alfred Newton, Kidder & Coues, Sclater & Salvin, Garrod, W. K. Parker, Reichenow, Forbes, Gray, Sundevall, Wallace, Fürbringer, and others; while, finally, he himself published an illustrated memoir "upon this remarkable type" in the 'Journal of Anatomy and Physiology' (London) in July 1891.

It is not my intention to review the various opinions expressed by this last formidable group of authorities, for Shufeldt has already done so in his paper on the subject; but to anyone studying them it must be obvious that any facts, however trifling and modest, which may serve to throw light on the life-history, morphology, and affinities of a remarkable family are acceptable; and this must be taken as my excuse for the following notes.

Remarkable and anomalous as the Sheath-bills are in more ways than one, it is not so much that we are interested in them, as in their relations to neighbouring groups and in the part they may, or may not play in demonstrating the processes of evolution whereby the Skuas, Gulls, Terns, and Auks became differentiated from the main Pluvialine or Limicoline stock.

Did, for instance, these processes of evolution eventuate through continuous or discontinuous variations? Were the various Charadriiform groups or families originally instituted solely through saltations occurring in the germ plasm, or to what extent have environmental or functional stresses been responsible?

I. *Geographical Distribution.*

As is well known, the present-day distribution of the Chionididæ is ultra-southern. There is no evidence derived from fossil remains pointing to the fact that in past ages the group had a more northerly distribution. On this point there is a most complete palæontological blank. The

* Shufeldt gives references to all these papers in the publication just quoted.

range of the family, as at present known, does not extend farther north than the parallel of 45° S. (this in about the meridian of 40° E.), nor farther east than the meridian of 80° E., or farther west than about the meridian of 80° W.

This distribution, it will thus be noticed, only comprises the more extreme southern regions of the Atlantic and the western moiety of the southern Indian Ocean, leaving the eastern part of the southern Indian Ocean and the entire ultra-southern Pacific unoccupied. In other words, of the Antarctic marine belt circumscribing the world in these southern regions, only a sector equal to less than half the entire belt is concerned.

Within the limits defined above, the various species comprising the Sheath-bill family may be divided into two groups, corresponding to the geographical distribution of the two genera which have been differentiated. These two groups may be called the *Chionis* group and the *Chionarchus* group, and their distribution, as at present known, is as follows :—

(1) The *Chionis* group.—Birds belonging to this genus have been recorded from the extreme southern portions of South America, comprising part of the southern coast-line of Patagonia, the Straits of Magellan, Tierra del Fuego, and Staten Island (the type-locality of *Chionis alba*). They have also been recorded from the Falkland Islands (? breeding), South Georgia, the South Sandwich group, South Orkney, and Booth-Wandel Island (Graham Land).

(2) The *Chionarchus* group.—Species belonging to this group have been recorded from Kerguelen Island, Prince Edward's Island, Marion Island, Heard Island, and the Crozets.

Thus Notogæa and its southern continuations is, at any rate at the present day, entirely left out of account; for the evidence of the occurrence of the Sheath-bill in New Zealand waters was certainly founded on error. It may be also stated that in the large collection of fossil bird-remains collected by Dr. H. O. Forbes in the Chatham Islands, that

well-known authority has found no evidence pointing to its former residence there, and the same deduction applies to Lord Rothschild's collections from the same locality in so far as they have been worked out. Nor has the Sheath-bill been recorded on any of the expeditions entering Antarctica by way of Queen Victoria or Edward the Seventh Lands. From what has been written of Antarctica as a connecting-link between South America and Australasia, such a limited distribution in Antarctic seas is interesting.

Osteologically the two groups above mentioned are characterised by perfectly obvious differences, which are, however, practically confined to the skull. There are also very obvious and distinct differences in more superficial characters, such, for instance, as the wattling and caruncu-lation of the face, the colour of the soft parts, the arrange-ment of the horny sheath embracing the upper mandible, and the presence or absence of bare spaces on the side of the face.

In spite of such manifest generic differences, Milne-Edwards (Ann. Sc. Nat. ser. 6, xiii. 1882, art. 4, p. 24) has expressed the opinion that generic differentiation between these two groups is unnecessary and uncalled for. In con-nection with such a question it is probably not generally realized that the distance separating the nearest points of the territorial limits proper to the two groups is something in the neighbourhood of 4500 miles, a distance which would appear to be adequate enough for the deep-seated effects of isolation. Even from the Crozets to Kerguelen the distance works out at something like 1500 miles.

As regards the southern limits to which the distribution of the family extends, it would appear that these are roughly represented by the Antarctic circle, beyond which it seems doubtful if the birds range. In the 'Ibis' (1895, p. 165) there is a note by Tristram to the effect that a specimen of "*Chionis*" was obtained by Dr. Gunn, surgeon on the 'Terror' during the Ross Antarctic Expedition, in latitude 78° S. Eagle Clarke ('Ibis,' 1907, p. 349) records that it has been proved that Gunn was never in such a latitude, so

that there seems no doubt but that this record was founded on error. In addition to this, no example of (*Chionis* has ever been recorded by any of the expeditions which have explored the Antarctic continent in the neighbourhood of Ross Bay, Victoria Land, &c.; so that the Booth-Wandel Island record, off Graham's Land in 65° S. lat. (French Antarctic Expedition), probably represents the farthest southern limit up to date. In addition to these land-records, representatives of the family have been met with far out at sea, many miles from land. Thus Eagle Clarke (*l. c.*) records that on the voyage of the 'Scotia' (Scottish National Antarctic Expedition), while the vessel was midway between the Orkney and Sandwich group, that is to say 300 miles from land, Sheath-bills (*Chionis alba*) were observed, the exact position being 59° 44′ S. and 36° 40′ W. According to observations made on the 'Scotia,' *Chionis alba* does not appear to penetrate into the Weddell Sea, and the most southerly point at which it was observed on this expedition, was 61°.

II. *Life-history and Habits of the Sheath-bills.*

Observations on these may be found in the 'Philosophical Transactions of the Royal Society,' vol. clxviii. 1879; in a paper by Kidder & Coues (Bull. U.S. Nat. Mus. No. 3, 1876); in an article by Alfred Newton in the 'Encyclopædia Britannica' (9th Ed.); in another by Prof. T. H. Studer of the University of Berne (C. R. Congr. Orn. iii. pp. 275–276); in the report by Menegaux on the Birds observed and collected on the French Antarctic Expedition (Exp. Antarc. Franç. 1903–5, Oiseaux, 1907); and in a recent and most interesting account of these birds compiled by Eagle Clarke from the records of the naturalists of the Scottish Antarctic Expedition ('Ibis,' 1906, p. 182).

With this bare allusion to some writers on the subject under notice I should have been content, were it not for the fact that certain points in the life-history and habits of the Sheath-bill would possibly appear to bear on the question of its affinities, and were it not also for the fact that certain statements which have been made in connection

with this subject seem to call for comment. Prof. Studer (*l. c.*), for instance, has stated that the horny sheath which embraces the base of the upper mandible protects the nasal orifices when the bird is feeding on the eggs of Cormorants and Penguins, of which it is very fond. That this is a physical and anatomical impossibility will, I think, be apparent to anyone who has examined the bill of a Sheath-bill. Moreover, this sheath varies in its morphology, not only in different genera, but in different species of the same genus, e. g. *Chionarchus*.

The same author also states that the chick on hatching is blind (that is to say that the eyelids are unopened). Prof. Studer, I presume, is simply quoting from information supplied to him, but unfortunately does not give his authority. The question is a very interesting one, because if the young of the Sheath-bills are in truth "blind" on hatching, we have a very anomalous condition, since, so far as I am aware, there is no other proved instance of it in the Waders. From an examination of a fine series of embryos of *Chionarchus minor* collected during the 'Challenger' Expedition (1873–6), and which are preserved in spirit in the British Museum collection, I at first came to the conclusion that the condition of the eyelids (which were in all cases open) proved beyond doubt that the chick is *not* "born" blind. However, since reading a paper by Dr. Casey A. Wood* on "The Eyelids and Lacrymal Apparatus of Birds" ('Ophthalmology,' Seattle, U.S.A., July 1915), I have to acknowledge that the open-eyed condition in the embryo-chick appears to prove nothing of the sort. Dr. Wood, for instance, says: "Unlike man and many other mammals, there is no true union of the conjunctivæ of the two lids before a bird is born. In the Sparrow (probably in all the Passeriformes) the lids are wide open during embryonic life, but as soon as the bird is hatched the eyes are closed, and remain closed for several days. There is no evidence that any organic union occurs between the lid-margins in these 'born-blind' birds. In all probability the closed eyes

* See also notice on p. 174.

are due to tonic contraction of the orbicularis as a light-reflex act."

I have examined the margins of the lids in certain Passeres (embryonic or just hatched), and, as Dr. Wood states, there does not appear to be any signs in the epithelial covering of these margins pointing to any organic union. It would appear, therefore, that we cannot predict from a mere inspection of the embryonic avian eye whether its possessor will or will not be "blind" in the first days of its existence after hatching.

Eagle Clarke (*l. c.*) also states that "the newly-hatched young (of *Chionis alba*) are clad in brown down *with conspicuous bare patches*" (italics mine). Possibly these bare patches were only evident before the down had thoroughly dried out after hatching; for in a chick which I took out of spirit (see above), and which had been either on the point of hatching or only just hatched, no bare patches were evident after the down had dried, although, before this took place, bare apteria, devoid of any sort of downy feathering, were evident.

I mention this because, from the various accounts of the nestlings which I have read, with the exception of Prof. Studer's, just alluded to, it does not appear clear whether or no the chick is nidicolous or nidifugous. If the Sheath-bill is a pure and simple Limicoline bird, one would expect it to be nidifugous; if, on the other hand, it is partly Larine, it might be for some time nidicolous. The chick of *Dromas*, a form which presents several Larine characters, is, for instance, nidicolous, but this may be due to force of environment. From remarks made by Menegaux in his report on the Birds of the French Antarctic Expedition (Exped. Antarct. Française, 1903–5), it would appear, by inference, that the chick stays for a long time in the nest.

Eagle Clarke (*l. c.*) states that "Sheath-bills were seen to revel in garbage of every description, including the excrement and placentæ of seals. They are well known to be very fond of the eggs of Penguins and Shags, which they

break open and feed on, while they have actually been seen to rob sitting birds. This is mentioned by Eagle Clarke, Menegaux, and Eaton (Phil. Trans. Roy. Soc. vol. clxviii.). Such habits are sufficiently surprising in a Wader, and are more reminiscent of a Skua or a Gull.

On a pap formed of the placentæ of seals, the contents of eggs, and small crustacea (Isopods), on which the Sheath-bill also feeds, one could well imagine that the young are nourished by the parents for some time and while still in the nest. Eaton records that the Sheath-bill also feeds, between tide-marks, "on mussels, enteromorpha, and ulva."

The birds nest in colonies on the edge of Penguin or Shag rookeries, the nests being "placed in crevices of rocks or underneath boulders on the moraine," sometimes ten or twenty feet only above sea-level, at other times a good deal higher up. One was found during the Scottish Expedition, 100 feet up on a moraine and "right in the midst of the Penguins" (Eagle Clarke). The nests were mainly composed of the shells of Penguins' eggs, bones, feathers, and a number of limpet-shells (Eagle Clarke). Eaton (*l. c.*) says: "The nest is a simple construction without a lining, and consists of a heap of dried seed-stalks of *Pringlea antiscorbutica* or tufts of *Festuca erecta*. Occasionally old burrows of *Prion* or *Halobæna* are occupied." In the South Orkneys the birds were migratory, and, in the main, only visited these islands to breed. During winter only some twenty or thirty remained and "eked out an existence on the refuse odds and ends which were daily thrown out from the 'Scotia'" (Eagle Clarke); a proceeding, it may be added, which does not suggest the habits of the normal Wader.

III. *Pterylography.*

A. Embryo of *Chionarchus minor*, nearly ripe, obtained from Kerguelen Island on the 'Challenger' Expedition and now in the collection of the British Museum.

The type of down-feathers presented by this and all the embryos I have examined is prepennal only. These prepennal down-feathers are disposed in well-defined and

strong pterylæ or feather-tracts, which are very clearly seen in the accompanying drawings. In the embryo the apteria are conspicuous, but when the prepennal down-feathers have dried after hatching they are apparently hidden, judging only from what takes place in spirit-specimens. The apteria are conspicuously bare and smooth, with not the least sign of preplumulæ. In coloration the prepennæ are greyish brown, lighter towards the base, darker at the tips of the rami, where they end in long thread-like filoplumes devoid of radii. These prepennæ have the typical structure described by Mr. W. P. Pycraft *, but, judging from the banded appearance of the radii, these seem to be furnished with strong fila. The microscopic details will be described in a forthcoming paper on *Dromas*.

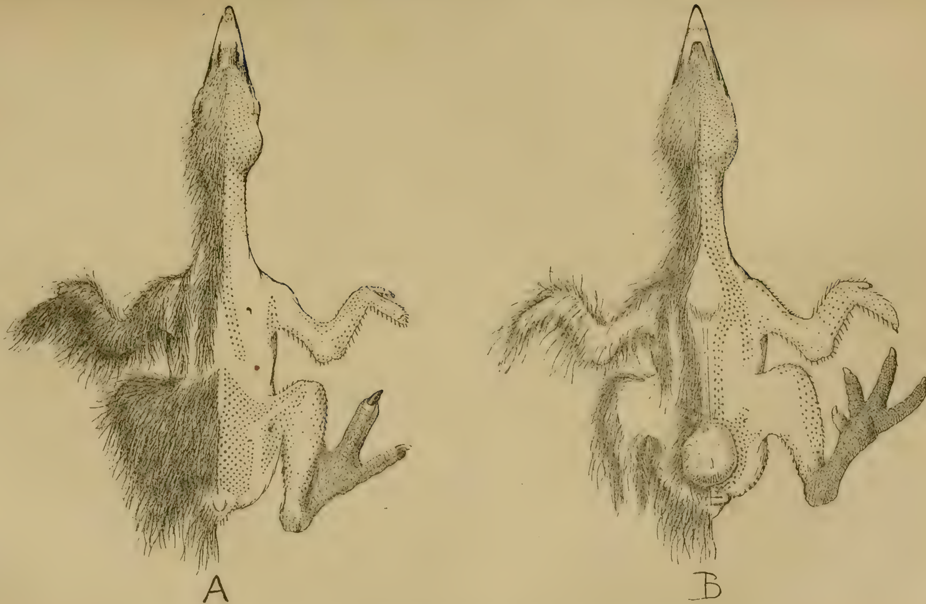
As regards the feather-tracts, these are depicted so clearly in the illustrations that no very detailed description seems necessary.

The *Pteryla capitis* is strongly marked, and evenly distributed over the vertex, sides of the face, and inter-ramal region.

The *Pt. colli* splits slightly more than halfway down the neck into a dorsal and ventral tract, both strongly marked. At about the level of the acro-coracoid the dorsal tract (*Pt. colli dorsalis*) splits into a strongly marked fork, the two ends of which terminate about the level of the tip of the scapula. There is a distinct break here in what has been described as the spinal tract, so that what might be looked upon as the dorsi-sacral tract appears to have an independent existence (*cf.* text-figure 1 A). This dorsi-sacral tract is strong ; it is narrowly bifurcated at its proximal extremity, and does not appear to be so constricted at its termination at the base of the uropygium as is usual in the Waders. It will be noted that laterally it extends well outwards along the anterior margin of the femur. The

* "Contributions towards our Knowledge of the Pterylography of the Megapodii," Willey's Zoological Results, pt. iv. Camb. Univ. Press: April 1900. (See also Brit. Birds Mag. vol. i.)

Text-figure 1.



Embryo of *Chionarchus minor* to show the distribution of the down and feather tracts.

A. Dorsal view. B. Ventral view.

K 2

femoral tract (*Pt. femoralis*) is strongly defined, and has the shape of a scalene triangle.

The humeral tract (*Pt. humeralis*) is sharply defined and calls for no comment.

The uropygium is not tufted. The orifice of the gland is merely indicated by an invagination of the skin. It is not prolonged in the form of a nipple. There are twelve tail-feathers with twelve coverts.

The ventral tract (*Pt. ventralis*) splits as usual (in the Waders) into a median and a pectoral division (see text-figure 1 B). Except that two divaricate extensions of the median tract towards the inguinal region may be observed, it calls for no comment.

Rhamphotheca. The curious horny sheath so characteristic of the Sheath-bills is in the embryo observed to be concrete with the horny substance of the bill, being only indicated by a faint line of demarcation.

Podotheca bare, reticulate.

Claws. There is a distinctly visible claw on the pollex. Those of the toes are strong, blunt, and galline in appearance.

Toes slightly webbed at their bases, with a lateral fringe-like extension of the podotheca.

Summary.—Pterylosis limicoline*, presenting its own slight peculiarities and no gallinaceous traits. Nitzsch says *Chionis* has exactly the pterylosis of *Recurvirostra*. Unfortunately I have been unable to secure any embryos or adults of *Recurvirostra*, *Hæmatopus* or *Stercorarius* with which to make a comparison with the pterylographical features of *Chionarchus*. There are well-marked points of distinction in comparison with the pterylosis of *Larus*, which I have carefully examined. In general appearance the chick of *Chionarchus* is very Skua-like. The coloration of the down is a uniform smutty brown with no indication of pattern whatever, except that the head is lighter in colour than the rest of the upper parts and the under parts dirty white.

* Using the word limicoline in a broad sense.

B. *Chionis alba.* Immature example, half-fledged; from Laurie Island, South Orkneys (Jan. 1904). In the collection of the National Scottish Museum, Edinburgh.

This interesting specimen was very courteously sent to me for examination by Mr. Wm. Eagle Clarke. It has already been illustrated in 'The Ibis' for Jan. 1906, but the accompanying illustration (text-figure 2) depicts it in greater detail and from a different aspect. Considered as an example of a young Wader, it presents what one might almost describe as a weird appearance. The following notes seem, in view of the aberrant nature of the Sheath-bills, to be worth recording:—

Nestling, half-fledged; no indication on label of its probable age. The plumage consists of neossoptiles and teleoptiles, with no indication of mesoptiles. The neossoptilic feathers may be again subdivided into prepennæ and preplumulæ.

(a) *Teleoptiles.*—White definitive or contour-feathers, apparently similar to fully adult contour-feathers, are to be observed on the wings (primary and secondary remiges and coverts); in the tail, where they are not so strongly developed as on the wing; over the scapular region (so-called humeral tract); in the mid-scapular region (corresponding to the forks of the anterior spinal tract and forming the mantle); over the rump and uropygium (corresponding to the posterior spinal tract); and in the region corresponding to the femoral tract (not shown in the drawing).

On the ventral surface, white contour-feathers may be observed on the whole of the fore-neck and upper breast, just forcing their way through a thick growth of bluish-grey down (preplumulæ), which latter is very conspicuous. On the lower breast, flanks, and abdomen white contour-feathers are more conspicuous still, and are tipped with greyish-brown prepennæ.

(b) *Preplumulæ.*—Conspicuous bands or tracts of these feathers are seen along the preaxial borders of the wings, and in tracts apparently corresponding to the *Apteria spinale*, *A. colli laterale*, and *A. trunci laterale*. Towards

the flanks they are replaced by prepennæ, which are still attached to the rapidly-growing contour-feathers. They have already been described as conspicuous on the fore-neck and breast.

Text-figure 2.

Chionis alba. Nestling half-fledged, from above.

(c) *Prepennæ*.—These are most conspicuous at the ends of the wing-coverts, tail-feathers, over the thighs and legs (femoral and crural tracts), and on the flanks. A few may be seen over the fore-neck and breast.

On the head (vertex) and back of the neck prepennæ

down feathers are conspicuous, but are somewhat degenerate in structure. As regards the vertex and occiput, they are chiefly disposed towards the sides, the mid-region of these parts being occupied with preplumulæ. The prepennæ extend forwards on the head to the supraocular region of each side. Degenerate prepennæ are seen on the chin and below the malar region. A bare space (? colour in life) surrounds the eye, and another bare space is to be noted over the malar region.

Bill hard and well-developed; sheath ill-developed, nearly concrete with rhamphotheca.

Legs, *feet*, and *claws* extremely well-developed, and in size appear to be out of proportion to apparent age of the bird; claws like the claws of an adult Grouse in point of strength and development.

This young bird is obviously older than it looks at first sight, and the young of the Sheath-bills are evidently nidicolous.

Adult Sheath-bills.—As is well known, the plumage of the adult Sheath-bill is of uniform pure white colour, and the general appearance of the bird is much like that of a Ptarmigan. In the Ptarmigan and other Arctic animals the white (winter) plumage is, or has been, generally regarded as procryptic and as affording protection from enemies amidst a snow-covered environment. In the case of the equally white Sheath-bill, it is interesting to reflect that there are no birds of prey in the Antarctic Islands or any carnivorous land animals. Indeed, from all accounts the Sheath-bill itself is something of a bird-of-prey in a small way.

In Antarctic latitudes the chief "bullies" are the Skua and the Albatros, more especially (as Mr. Ogilvie-Grant informs me) *Macronectes* (= *Ossifraga*). In connection with this question of what possible use it can be for the Sheath-bill to have a pure white plumage, Mr. Grant tells me that *Macronectes giganteus* has two phases of plumage coloration, a white phase and a dark grey phase, which

have nothing to do with seasonal change. Moreover, these distinctive phases are distinguishable in the young in down. For instance, Mr. Grant showed me two young, said to be eight weeks old, taken by Mr. Bennett from the same colony on the South Orkneys, which are especially interesting, one being pure white (both as regards neossoptyles and teleoptiles) and the other dark slaty-grey—the grey in this case also affecting both the down-feathers and the contour-feathers, which had already come through, although the down-feathers were not so dark as these latter.

IV. *Genera and Species of Chionididæ.*

A. Chionis Forster, Enchiridion Hist. Nat. 1788. p. 37. Type, *C. alba.*

Species :—

(*a*) Chionis alba (Gm.), Syst. Nat. i. 1788, p. 705 : New Year Island (coast of Staten Island).

B. Chionarchus Kidder & Coues, Bull. U.S. Nat. Mus. No. 3, 1876, p. 116. Type, *C. minor.*

Species :—

(*a*) Chionarchus minor (Hartlaub), Rev. Zool. for 1841, 1842, p. 5 : type-locality unknown. Type in the Leyden Museum.

It appears doubtful whether, as is generally stated, the Kerguelen Island Sheath-bill is identical with the bird named by Hartlaub *C. minor*. Hartlaub, in his original description, gives its location as "country unknown," and describes it as *distinctly smaller* than *C. alba*. As a matter of fact, skins of Sheath-bills from Kerguelen Island give measurements which are quite as large as those of *C. alba*.

The following comparative measurements, taken from the skeletons of the two forms, may also be quoted :—

(1) Sternum, length (over all)—*Chionarchus "minor"*.. 67 mm.
„ „ „ *Chionis alba*..... 64 mm.
(2) Humerus—*Chionarchus "minor"* ..... 74 mm.
„ *Chionis alba* ..... 71 mm.

(3) Femur ..... *Chionarchus* 60 mm. *Chionis* 55 mm.
(4) Tarso-metatarsus „ 49 mm. „ 43 mm.
(5) Middle toe „ 48 mm. „ 39 mm.
(6) Skull:—
(*a*) From occipital protuberance to tip of premaxillæ—
(1) *Chionarchus "minor"* ..... 70 mm.
(2) *Chionis alba* ..... 65 mm.
(*b*) Transverse diameter from tips of post-orbital processes identical in the two forms.
(*c*) From tip of premaxillæ to end of nasal processes of the same.
(1) *Chionarchus "minor"* ..... 35·5 mm.
(2) *Chionis alba* ..... 30 mm.

From which data it will be noticed that, far from *Chionarchus "minor"* being the smaller bird, it is, in fact, actually larger. It seems therefore probable, if not certain, that Hartlaub's *C. minor* did not hail from Kerguelen Island, and the deduction is that it must have come from either Marion Island or from the Crozets. (I have not seen a skin from Heard Island = *C. nascicornis* of Reichenow.) Both the Marion Island and Crozet forms are very obviously smaller than *C. "minor"* from Kerguelen. It is also obvious that further remarks would be useless until the type of *C. minor* in the Leyden Museum has been examined, which at the present time is impossible.

(*b*) Chionarchus marionensis (Reichenow), Deutsche Süd-Polar Exp. i. 1908, p. 566.
Type-locality — Marion Island (Prince Edward Island, Southern Indian Ocean).

(*c*) Chionarchus nascicornis (Reichenow), Ornith. Monatsb. xii. 1904, p. 47.
Type-locality—Heard Island (Southern Indian Ocean).

(*d*) Chionarchus crozettensis (Sharpe), Bull. B.O.C. v. 1896, p. xliv.
Type-locality—Crozet Islands (Southern Indian Ocean).
Type in Brit. Mus.

V. *The Comparative Osteology of the Chionididæ.*

In the many papers which have been written on the subject of the anatomy and affinities of the Sheath-bills, so much stress has been laid on the affinities of these birds with the Oyster-catchers (Hæmatopodidæ) that attention has been apparently distracted from certain Skua-like features in the skulls of this group. In the following notes (of a somewhat general character) I shall endeavour to demonstrate these Skua-like features; but just as I believe that such Oyster-catcher-like characters as are presented in the skeletal features of the Sheath-bills are not necessarily evidence of close affinity, but may have been impressed on them through functional or environmental stresses or through mere parallelism, so I would not be taken as implying that because in the skull of the Sheath-bill there are certain features which bear a strong resemblance to similar features in the skull of a Skua, that this necessarily implies that the Sheath-bills are more closely related to the Skuas than to any other Charadriiform group (see also Summary). Incidentally I shall hope to demonstrate that the gap which separates the Skuas (Stercorariidæ) from the Gulls (Laridæ) is much greater than has apparently been hitherto suspected.

Finally, there is another point to which I think attention should be drawn. There is a somewhat time-honoured belief that gallinaceous and columbiform characters are reflected in the osteological peculiarities of the Sheath-bills. For this belief and for the statements which have been made in this connection, there appears to be no real evidence at all. If the Sheath-bills possess any gallinaceous or columbiform features at all, they are concerned with the most superficial characters.

The Skull.

Occipital Region.—The occipital condyle is circular (not bi-lobed as in Gallinæ), and a distinctly constricted neck is to be observed. The occipital foramen (foramen magnum)

is somewhat rounded as in both the Gulls and Skuas—the transverse diameter being longer than the sagittal. The plane of the whole occipital area, including the plane of the foramen magnum, makes a sharp angle with the basal plane of the skull (a larine and Skua character). As a consequence, these planes look distinctly backwards as well as downwards. In *Hæmatopus* the plane of the foramen magnum looks directly downwards; and the same is nearly true of the pluvialine genera *Charadrius* and *Squatarola*. The supraoccipital ridge does not sweep forwards and downwards to become merged in the inner border of the paroccipital process, but ends abruptly in the middle of either margin of the occipital foramen as two rather prominent spinous processes, on the outer sides of which is a distinct and well-defined groove (for the exit of the sinus canal). These processes are not nearly so prominent in *Hæmatopus*. The arrangement in *Charadrius* is somewhat different, the groove just mentioned being partly bridged.

The lambdoidal ridge is not so sharply defined as in the Laridæ. It is thicker and more osseous, and instead of being continued outwards, forwards, and downwards as a sharply defined ridge to run into the outer border of the paroccipital process, it sweeps abruptly inwards as a thickened rounded and more osseous ridge to terminate near the aforesaid processes on either side of the foramen magnum. As a result, the occipital area is divided in the Chionididæ into two distinct and hollowed surfaces separated by a prominent ridge, and the identity of the supraoccipital and exoccipital bones (which are separate entities in the embryo) is thereby rendered more obvious (*cf.* figures). This appears to be a pluvialine character, as it is to be noted in *Charadrius*; but it is more exaggerated in the Sheath-bills. An interesting fact to note is that it is to be observed in *Stercorarius crepidatus*. It is indicated in *S. parasiticus*, and also in *Hæmatopus*, but is hardly present in *Megalestris* (*antarctica*), which appears to be a more specialised stercorarine genus than the rest. In the Gulls (Laridæ) the separate identity

of the supraoccipital and exoccipital is completely obliterated. There are no supraoccipital fenestræ. These are also absent in the Skuas and Gulls. They are present in *Hæmatopus* and the Plovers (Limicolæ).

Parietal Region.—Comparing this region with that of the true Gulls (Laridæ) the absence of the deep and conspicuous temporal grooves is at once obvious. Without entering into details, it may be pointed out that the general configuration of the fronto-parietal region in the Sheath-bill genera is quite peculiar (*cf.* text-figure 3), the vault of the skull frontalwards being prominent, smooth, and high, without any evidence of sagittal grooving. The morphology of this region differs widely, in fact, from that peculiar to the Gulls or Charadriidæ. A very interesting point is here to be noted, viz., that the deep and prominent temporal grooves so conspicuous in the Laridæ are (as in the Chionididæ) completely missing in the Skuas, a fact which appears to have been hitherto overlooked. These deep temporal fossæ are, for instance, generally quoted as being distinctly larine characters, the word larine being used in a wide sense so as to include the Skuas. As a matter of fact, the depressions for the attachment of the temporal muscles in the Skuas, small in extent as they are, and strictly limited to the sides of the skull (squamosal region, etc.), are even smaller than in the Chionididæ; and in their position and limits are distinctly pluvialine. To be quite exact, however, this only applies to the genus *Stercorarius*, since in *Megalestris* we get a stage somewhat intermediate between *Stercorarius* and the Gulls proper, although even in *Megalestris* the surfaces for the attachment of the temporal muscles still remain shallow and ungrooved. The importance of these so-called larine grooves as characters which have any real significance in relation to affinities is thus very distinctly diminished, for their presence or absence appears to be more or less a matter of functional stress, or dependent upon the use to which the temporal muscles are put in the process of obtaining food.

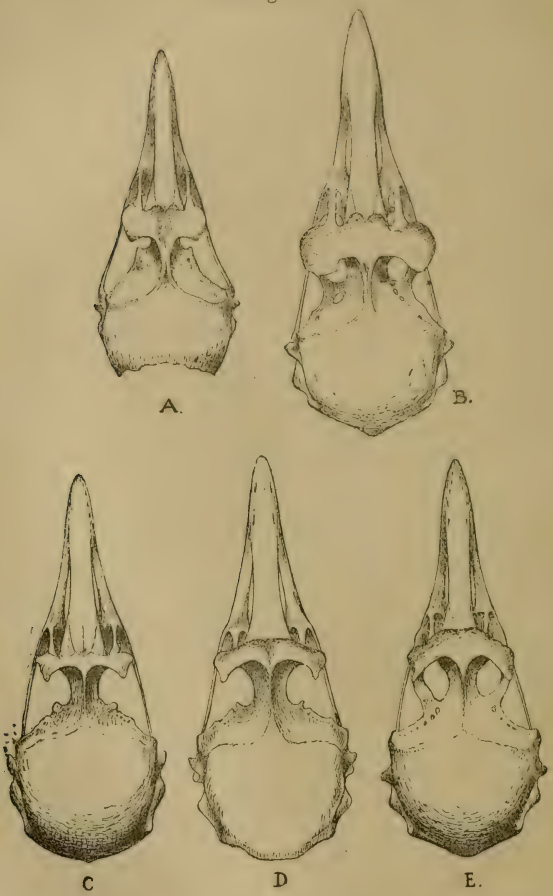
In any case, however, we must be cautious in drawing deductions as to affinity from the resemblances noted in the parietal region in the Sheath-bills and the Skuas, for this might indicate that it was rather that the Skuas were more Plover-like than the Gulls than that the Sheath-bills were more Skua-like than the Plovers.

A word may be added in connection with the general shape and configuration of the fronto-parietal region in the Sheath-bills. Shufeldt (Journ. Anat. & Phys. Lond. vol. xxv. 1891, p. 509) has thus expressed himself upon it: "As for the vault of the skull and the greater portion of its posterior aspect, particularly the supraoccipital region, it is all strongly gallinaceous in the Sheath-bill, and strikes us at once upon the most superficial examination." Such a similarity, whether it exists or not, would not appear to have much importance one way or the other, but I am obliged to confess that personally I have failed to see the resemblance. As an indication of any gallinaceous affinity in the Sheath-bills, the statement seems to call for criticism, and to be misleading.

Frontal Region.—The morphological details of this region will be more obvious from an inspection of the accompanying text-figures than from any amount of written description. These text-figures depict the skulls of various numbers of the Sheath-bill family as seen from above. Three of them represent skulls of *Chionis alba*, in which we observe variation due apparently to age and ossification, or very possibly to the influences of isolation; another represents the skull of *Chionarchus minor*, and another the skull of *Chionarchus crozettensis*.

As is obvious from the figures, the main features of this aspect of the skulls of the Sheath-bills are the strongly marked and deep supraorbital depressions, which are merely separated in the middle line by a thin sagittal ridge, and the very peculiar and distinctive shield-like lacrymals. As regards the supraorbital depressions, these, in form and structure, are obviously modifications of what is seen in the

Text-figure 3.



Dorsal view of the skulls of :—

A. *Chionarchus crozettensis*; B. *C.* "*minor*":
C. "*Chionis alba*, bought of Mr. Thompson"; D, E. *Chionis alba*.

Skuas, Gulls, Oyster-catchers, and *Dromas* (Crab-Plover), or, to be probably more exact, they are modifications of these structures, as they were possessed by an ancestral form from which all the groups above mentioned have possibly sprung by discontinuous variations.

Just caudad of the projecting lacrymals there is a prominent sickle-shaped notch with smooth and rounded edges, and this may be converted by a bony bridge into a complete foramen or left incomplete.

It is interesting to note that in the case of the Skuas this notch may also be bridged across by well-organised osseous connections which appear to be something very distinctly more than ossified ligaments; but this, so far I am aware, only applies to the genus *Megalestris*, and even in that genus to New Zealand types only. I have not found a skull of *Stercorarius* in which this notch is converted into a complete foramen.

Thus in both the *Chionis* and *Chionarchus* groups, as well as in the Skuas, we find skulls indicating transitions as regards this supraorbital region, from a more generalised to a more specialised condition, unless, indeed, these progressive steps are simply indications of age.

It would appear, however, judging from the various localities from which these skulls have been collected, that the effects of isolation in this connection cannot be ignored; but until a far greater series of skeletons is available it would be dangerous to draw any conclusions. Attention, however, is especially drawn to the differences presented in the morphology of this region in the case of the skulls of *Chionarchus minor* and *C. crozettensis*, especially as regards the shape of the lacrymals (*cf.* text-figure 3). In passing, attention is also drawn to the fact that in the genus *Chionis* the sagittal ridge separating the supraorbital depression is single. In *Chionarchus* it is double.

Shufeldt (*l. c.*), writing of these notches, says: "Their form in *Chionis* agrees best with *Hæmatopus*, but in *Hæmatopus* the foramina are not entire, their lateral margins having given

way converting them into deep notches." As will be seen by a reference to the figures, the notches in the genus *Chionis* may or may not be converted into complete foramina, and the same applies to the genus *Chionarchus*, so that it does not appear to be a question of the lateral margins having "given way" in *Hæmatopus*, but rather that they are not so specialised, or do not have the same tendency to specialise, as in the Sheath-bills (or Skuas). In my opinion, however, the form and general configuration of the notches and supraorbital depressions agree best with *Stercorarius*, but one might almost as well have compared them with any of the aberrant Plover-like forms already mentioned, and not only with these but with *Squatarola*, in which we can observe a more generalised but still fundamentally similar condition appertaining to these supraorbital grooves and the notches under discussion.

As regards the lacrymals, the orbital portions of these in the Chionididæ present considerable variation both in form, structure, and size, corresponding not only to generic differences but also to intra-generic variations. They are quite peculiar to the group, but there is a skull in the Natural History Museum of uncertain locality, and labelled "*Chionis alba*, bought of Mr. Thompson," in which the lacrymals appear to be of a more generalised form and to come rather close to those of *Hæmatopus* (*cf.* text-figure 3 C).

In *Chionis* the lacrymals are distinctly pneumatic, and there is a varying amount of hyperostosis. In *Chionarchus* the lacrymals are flat plate-like structures. The descending processes of the lacrymals in the Sheath-bills are somewhat abortive, but pluvialine in form and structure. It may be noted here that these processes in the Skuas and Gulls are sharply contrasted. In the Gulls (Laridæ) the descending process of the lacrymal makes a very sharp angle with the orbital process, and approaches the *middle* or *lower* portion of the outer edge of the antorbital plate from a long way distad of it. In the Skuas the angle made is a right angle, and the descending process passes perpendicularly to the *upper* angle of the outer edge of the antorbital plate. In

the Gulls, moreover, the antorbital plate has its extero-inferior angle continued downwards and outwards to a pointed process. In the Skuas the antorbital plate is right-angled in shape.

The "pointed process" of the antorbital plate in the Gulls is apparently reminiscent of "a structure of intense interest" referred to by Prof. W. K. Parker (Trans. Linn. Soc. Lond. 2nd Ser. Zool. vol. i. pt. iii. 1876, p. 150) as the "os uncinatum."

In *Hæmatopus* the morphology of the lacrymals and antorbital plates is quite peculiar to itself and very different from the arrangement seen in the Chionididæ, in which, as has been indicated, these antorbital plates are not ossified.

Shufeldt (*l. c.*) sees gallinaceous characters in the lacrymals of the Sheath-bills. He says "they are very much like what they are in the Fowls, agreeing with these elements as we find them in any Grouse of the first year, but lacking the peculiar descending spine-like processes of the adult birds; thus both in *Chionis* and the Fowls we find the aborted antorbital plates to be in the same case." At the risk of appearing hypercritical, I am obliged to dissent strongly from this point of view, since statements of such a nature, coming from so well-known an authority, are unfortunately copied and perpetuated. In the first place, it may be bluntly stated that it would be difficult to find such strongly differentiated lacrymals as those characteristic of the Chionididæ and Gallinæ; while, in the second place, we find aborted antorbital plates in the Œdicnemidæ.

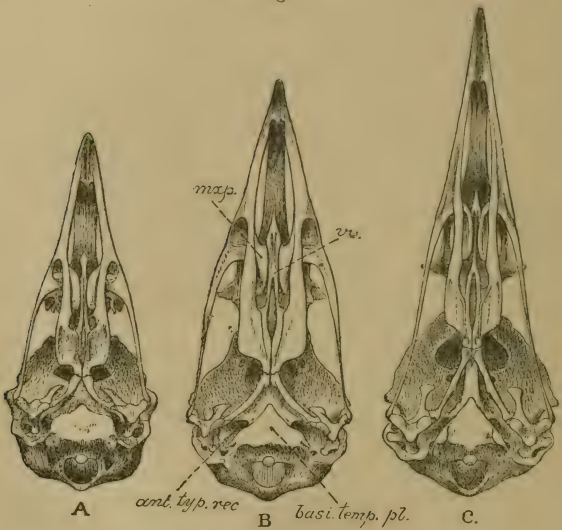
Base of the Skull.

A glance at the accompanying text-figures reveals the fact that, in a general way, the morphology of the basal structures in the Chionididæ come closer to the Skuas than to any other group.

In the Chionididæ the mammillated processes at the base of the basi-temporal plate are more prominent than in the

Stercorariidæ, but in both these groups we miss the very prominent and conspicuous downwardly-projecting tubercles at the postero-external angles of the basi-temporal plate, which are so characteristic of the true Gulls. Thus in this respect the Sheath-bills and Skuas are pluvialine, the

Text-figure 4.



Palatal views of the skulls of :—A. *Chionis alba* ;
B. *Stercorarius crepidatus* ; C. *Larus canus.*

ant. typ. rec., anterior tympanic recess ; *basi. temp. pl.*, basi-temporal plate ; *max.*, maxillo-palatine ; *vo.*, vomer.

postero-external angles of the basi-temporal plate ending in outwardly-projecting and spiculate processes. The basi-temporal and basi-occipital region in the Gulls and Skuas are strongly contrasted. The Skuas come close to the Sheath-bills in respect of the morphology of this region. In

the underlap of the apical portion of the basi-temporal plate and the arrangement of the eustachian tubes the Skuas present larine features, the Sheath-bills modified pluvialine ones. Shufeldt (*l. c.*), whom I am once again obliged to quote, states that the basi-temporal region in the Sheath-bills is strongly gallinaceous. This is a statement which I feel convinced could only have crept into the author's manuscript in error, so very far from the actual truth does it appear to be. As regards the palatal plates, pre-palatal bars, maxillo-palatine processes, maxillary processes, and the fenestræ distad of these last—all these, with the exception of the palatal plates, come closer to the like structures in the Skuas than to those of any other Charadriiform groups. The similarity of the arrangement of the maxillo-palatine processes and the presence of the fenestræ distad of the maxillary processes (*cf.* text-figure 4) in both the Sheath-bills and Skuas is very striking, as are also the disposition of the maxillary and palatal processes of the premaxillæ and the form and shape of the maxillo-jugal bars. In the Gulls (Laridæ) the fenestræ just alluded to are absent (*cf.* text-figure 4 C), while the morphology of the maxillo-palatine processes is strongly differentiated from the Skuas. As regards the maxillo-palatine processes, Shufeldt (*l. c.*) states that these "in *Chionarchus minor* are much like these bones as we find them in some of the Pigeons." I have been through a fair series of Pigeons' skulls in the collection of the British Museum, and I cannot trace the slightest resemblance between the maxillo-palatines in the two forms, nor can I discover any trace of columbine characters in the osteology of the Chionididæ. Referring to the palatal plates once more, these in the Sheath-bills, Gulls proper, Skuas, Oyster-catchers, and Crab-Plover (*Dromas*) present their own peculiar and respective characters. Those of the Sheath-bills appear to have been much specialised, along with those of *Hæmatopus*, away from the more generalised pluvialine type. There seems to be a Woodcock-like element in both, but this shortening-up of the plates in *Hæmatopus* and

Scolopax may be due to crowding, consequent on the rotation which has occurred in the skulls of these two forms.

Premaxillæ.—I fail to see any real gallinaceous characters in these. There is a certain superficial resemblance to a gallinaceous form of bill in the Sheath-bills, but this, I take it, is the outcome of functional stress, and is merely convergent in nature. The general shape of the upper mandible in the Sheath-bills has been evolved to suit a particular method of feeding, and is strictly peculiar to them among the Charadriiformes ; but if any comparisons are to be made, they must be made with reference to the bill of the Skuas, which they seem to approach closer than to any other charadriiform type. It must be remembered that the Sheath-bills live amidst rocky, stony, and more or less frost-bound surroundings. They "pick" their food, and do not bore for it like the Scolopacidæ.

It might be as well to state here that the nostrils of the Chionididæ are not holorhinal, as has been stated in the Catalogue of Birds, vol. xxiv. p. 710, evidently through a slip. As is, of course, well known, those of the Gallinæ are holorhinal.

Quadrate.—This bone presents its own peculiar features characteristic of the group, but in the length and form of its orbital process it presents a similarity to that of the Oyster-catchers. The articular facets for the mandible in the Skuas, Gulls, Oyster-catchers, and Sheath-bills present their own distinctive peculiarities, but those of the Sheath-bills agree closer with those of *Hæmatopus* than with the other two groups.

It is interesting to note that the quadrate in the Skuas and Gulls is distinctly contrasted—for instance, in the posterior surface of the shaft there is in the Gulls (Laridæ) a foramen leading into a pneumatic interior ; in the Skuas this foramen is either indicated by a simple depression or is entirely unindicated, the shaft appearing to be non-pneumatic. The shaft of the quadrate is also always relatively longer in the Gulls than it is in the Skuas, and

the orbital process is more slender and less truncated than it is in the Skuas, in which it is relatively shorter, wider, and with borders more parallel.

Vomer.—In *Chionis* the vomer is hastate in shape; in *Hæmatopus* it is much wider, and is bifurcated at its extremity, or, rather, is deeply notched.

The vomers of the Skuas and Gulls are easily contrasted, but are more like one another than they are like that of the Sheath-bill.

The *Parasphenoidal Rostrum* in the Sheath-bills presents no facets for articulation with the pterygoids (no basi-pterygoid processes). In *Hæmatopus*, as is well known, they are present.

The *Pterygoids* in *Hæmatopus* are short and typically pluvialine. In the Sheath-bills they are distinctly peculiar, being neither typically pluvialine nor larine. They are, however, closer to the pluvialine type than the larine. The pterygoids of the Skuas are certainly larine.

Other Skeletal Features.

As regards the rest of the axial and appendicular skeleton, a few notes of a general nature seem to be worth recording as throwing light on the affinities of the Chionididæ.

Humerus.—This bone is distinctly pluvialine in its features. The sub-trochanteric and tricipital fossæ are not so distinct or specialised as in the Laridæ. Both the ridge separating these fossæ and the fossæ themselves are, however, in the Chionididæ more sharply marked and accentuated than in *Charadrius* and slightly differentiated. The humerus of the Sheath-bills comes very close to that of *Hæmatopus* and *Dromas* in this respect.

On the palmar aspect of the head of the humerus the groove for the coraco-humeral muscle is not so deep or conspicuous as in the Laridæ or Stercorariidæ, but is more sharply marked than in *Charadrius* or *Hæmatopus*. In the

Gulls and Skuas this groove is deep and V-shaped, and very characteristic. At the distal end of the humerus the depressions for the brachialis muscle in the Sheath-bills and Skuas are closely similar, being nothing like so deep as in the Laridæ. As regards the curvature of the shaft, the humerus of the Sheath-bills is pluvialine; that of the Skuas larine. It may be here remarked that the sub-trochanteric fossa of the Skuas is very markedly differentiated from that of the Laridæ, so that from this difference the bones of the two forms could be recognised at a glance. In the Skuas, a circular opening with smooth and well-defined margins leads into a large pneumatic recess traversed by trabeculæ, and the tricipital fossa is inconspicuous. In the Laridæ the sub-trochanteric fossa is non-pneumatic, and a sharply-defined ridge, curving inwardly, separates it from the tricipital fossa.

In this respect the humeri of the Sheath-bills, *Hæmatopus*, and *Dromas* come closer to that of the Gulls than to that of the Skuas.

Phalanges.—The bony lateral expansion of the index digit is not subdivided into two fenestræ (as in the Gulls and Skuas) in either the Sheath-bills, the Oyster-catcher, the Crab-Plover, or the Stone-Curlews.

Sternum.—All that can here be said is that the general morphology of the sterna of the Sheath-bills, the Oyster-catchers, the Crab-Plover, the Skuas, and the Gulls presents its own peculiar and characteristic features. Comparisons seem quite futile. It is noticeable that in these sterna we have a series of resultant evolutionary products, which have been derived from a common ancestral type, or as the result of varying environmental or functional stresses. One peculiarity, however, may be noted about the sternum of the Sheath-bills, and that is that it entirely lacks the diagonal pectoral ridge on the inferior surface of the body of the sternum giving attachment to the outer border of the *pectoralis secundus*, which ridge, so far as I am aware, is present in all other Charadriiform types.

Coracoid.—In pluvialine types I have noticed that the

outer surface of the head of this bone is distinctly grooved ; in larine types it is flat and smooth. In this respect the Sheath-bills are pluvialine, the Skuas larine.

Pelvis.—The pelves of the Skuas and Gulls have easily recognised characters, which serve to distinguish them from other charadriiform types. For instance, the anterior iliac fossæ (on the dorsal surface of the ilia) are flattened and much less hollowed out than in pluvialine types, while the superior margins of these pre-acetabular portions of the ilia are not continued dorsally into the characteristic prominent hog's-back ridge which rides astride of the spinal processes of the sacral vertebra in the Plovers and their kindred. On the contrary, in the Skuas and Gulls this ridge has a flattened and shaved-away appearance, and this is a very characteristic feature. In these respects the pelves of the Sheath-bills and Oyster-catchers are pluvialine. They are also differentiated from the Gulls and Skuas in regard to their incurved ischiadic processes, their more massive build, and broader beam. The pelves of the Sheath-bills and Oyster-catchers nevertheless present easily-recognised peculiarities. Curiously enough, the pelves of the Skuas and Gulls seem more generalised—that is to say, less specialised away from the pluvialine type than either those of the Chionididæ or the Hæmatopodidæ. Thus in the sum of its characters or general appearance the pelvis of *Stercorarius* is very similar to that of *Charadrius pluvialis*.

The Pelvic Limb.—I have no more to say here about this than that in the Chionididæ the hypotarsus of the tarso-metatarsus is somewhat specialised and peculiar. In its features it appears to stand somewhat by itself as compared with adjacent groups. It is not larine. *Charadrius* even seems more larine in respect of this part, or, to be more correct, the Gulls are more pluvialine. It also differs from *Hæmatopus*, which again presents Gull-like propensities.

A good many writers on the Sheath-bills have referred to the resemblance that the legs and feet of these birds bear to those of the Oyster-catcher. These resemblances are more apparent than real, the bones of the pelvic limb being

distinctly differentiated in various minor details. The relative measurements are also different, as shown below :—

Length of femur	in *Chionis alba*	60 mm. ;	in *H. ostralegus*	50 mm.
„ tibio-tarsus	„	„	81 mm. ;	„	„	86 mm.
„ tarso-metatarsus	„	„	43 mm. ;	„	„	55 mm.
„ middle toe	„	„	38 mm. ;	„	„	41 mm.

Vertebral Column.—In the Sheath-bills there are only two cervico-dorsals ; in *Hæmatopus* there are three ; while the morphology of the hypapophyses of the cervical vertebra in the two forms is strongly contrasted.

Summary.

The sum of the characters presented by the skeletal, pterylographical, and other features of the Chionididæ point to the fact that this very specialised and well-defined Charadriiform group is more pluvialine than larine. It is, however, so specialised away from the "Plovers" that its inclusion in the limicoline suborder (Charadriidæ + Scolopacidæ) seems a matter of doubtful propriety.

Kidder & Coues (Bull. U.S. Nat. Mus.) thought that *Chionis* was a connecting-link closing the narrow gap between the Plovers and Gulls of the present day. In their opinion the Sheath-bills represented the survivors of an ancestral type, from which both the Gulls and Plovers have descended. In this opinion I think there can be no doubt that they were mistaken, since, among other reasons, the Sheath-bill is not a generalised type but a specialised one. It is probably nearer the truth to suppose that the Sheath-bills were differentiated as an offshoot from the main charadriiform stem before that stem had split into the charadriine and scolopacine branches, and that that offshoot was given off prior to the differentiation of the Skuas and Gulls ; or, as an alternative speculation, that the main charadriiform stem split into a limicoline and a laro-limicoline branch—such groups as the Sheath-bills, Crab-Plover, Pratincoles, Skuas, Gulls, Terns, and Auks arising from the latter by various stages of specialisation.

In its osteological features the Sheath-bill presents certain resemblances to the Oyster-catcher. Nevertheless, the Oyster-catchers are not so fundamentally specialised away from the Limicolæ, and the two groups are separated by enough deep-seated and important characters as to appear to forbid their being closely associated together, the likenesses between them being presumably the result of environmental or functional stresses. Garrod, for instance (P. Z. S. 1877, p. 417), comparing *Chionis* and *Hæmatopus*, says: "Nevertheless, although these birds are both schizorhinal, their skulls give indications of a very different affinity. *Hæmatopus* possesses supra-occipital foramina, basipterygoid articulations, and a bifid vomer." Again, he goes on to add: "My dissections of both *C. alba* and *C. minor* are quite in favour of a larine affinity."

It would be idle to deny that the skulls of the Sheath-bill and the Skua do not present very striking and remarkable resemblances. Moreover, it is in just those characters in which the skull of a Skua differs from the skull of a Gull that it resembles those of a Sheath-bill. But to declare that these characters are of such importance that they point to a close affinity between the Sheath-bills and Skuas, other than that they are members of the same order (Charadriiformes) or even of the same suborder (Laro-Limicolæ), would be another matter; for there is the question of parallelism and plasticity due to similar superficial stresses to be eliminated. My observations seem to warrant the opinion that the Skuas are more generalised, and stand closer to the true Limicolæ (Charadriidæ + Scolopacidæ) than do the Gulls (Laridæ) or the Auks; but the more attentively one examines the osteological features proper to and peculiar to a large series of differing charadriiform groups, the more impressed one becomes with the idea that each one of such groups represents a distinct evolutionary entity, which stands by itself and which had its origin in an independent process of discontinuous variation from a common stock. It is easy to say that such a series of groups merely represent the present-day

relics of a once-existent series of continuously intergrading forms, but it is stranger to reflect how extremely difficult it is to put one's hand upon what might be termed truly intergrading links.

With a view to investigating the question as to whether, if we went far enough back in time, we should find generalised forms of Gulls and Limicolæ which would disprove such suggestions as have just been tentatively put forward, I have lately examined the collection of fossil Charadriiformes in the British Museum collection. So far as one can form an opinion from the material available, a Gull or a Tern was nothing else than a Gull or a Tern as far back at least as the Upper Oligocene (cf. *Larus* (? *Sterna*) *elegans* Milne-Edwards). Again, a Sandpiper was a Sandpiper and nothing else (cf. *Totanus majori* Lydekker or *Tringa gracilis* Milne-Edwards); a Spur-winged Plover was a Spur-winged Plover, and so on. On the other hand, Marsh has described *Palæotringa* from the Cretaceous Shales of Kansas, which, if really a generalised limicoline, seems to controvert such ideas. The fact, too, that the Skuas in their cranial characters seem more generalised in the direction of the Plovers gives one pause to think; but such instances do not affect the fact that, although there may be a series of *progressive steps*, it does not necessarily follow that there were links connecting such steps. But whatever the truth may be as regards the mode of origin of such charadriiform groups as the Sheath-bills and others, the outstanding fact which has impressed me is that, in so far as their osteological characters are concerned, there is very little real difference between a Gull and a Plover, and certainly very little fundamental difference that can be expressed on paper. The statement that a Gull is only a highly specialised Plover is, I fancy, regarded by most ornithologists as a mere academic expression of a somewhat hazy idea. It is, in reality, a very literal and patent fact.

Finally, I may, perhaps, be permitted to quote Shufeldt's summary of his findings in regard to the osteology of the Sheath-bill (Journ. Anat. & Phys. Lond. xxv.) :—